May 10, 1934

OUTLINE OF INVESTIGATIONAL WORK ~~IN PROGRESS~~

at

Soil Erosion Experiment Station No. 4

Tyler, Texas

(Serving the Arkansas-Louisiana-East Texas, Rolling Sandy Lands Erosion Region)

U. S. Department of Agriculture, Bureau of Agricultural Engineering and Bureau of Chemistry and Soils, in cooperation with the Agricultural Experiment Stations of Texas, Louisiana and Arkansas.

Field Day, May, 1934.

The work upon erosion control at the Tyler Station centers around three main lines of investigation which are outlined in brief detail below.

I. Studies upon the relation of soil type and condition as affected by cultivation, treatment, slope, etc.

II. Studies upon the relation of vegetative cover or other natural protection, both alone and in combination with other methods.

III. Studies upon mechanical or engineering means as by terracing, etc., both alone and in combination with other methods.

I. RELATION OF SOIL TYPE AND CONDITION AS AFFECTED BY CULTIVATION, TREATMENT, SLOPE, ETC.

Special Factors that induce erosion: Using the data of average losses for the 1931-1933 period, for continuous cotton, no treatment, as a base: (1) doubling the slope length has increased the erosion loss from 19.06 to 35.76 tons per acre, or almost doubled it; (2) halving the slope length reduced the erosion loss to 13.03 tons per acre, or cut it about 1/3; (3) doubling the gradient of slope produced 41.33 tons per acre erosion, or more than doubled the loss; (4) removing the surface soil on the $8\frac{3}{4}\%$ slope, standard length plat, increased the erosion loss to 71.30 tons per acre, or increased it by $3\frac{1}{3}$ times. These losses and factors apply particularly to the dominant soil type of this region, Kirvin fine sandy loam, using a slope length of 72.9 feet as standard.

In other words, to keep the erosion losses at a low figure with clean cultivated crops, it is advisable to cultivate only the more gentle slopes; grow them on short protected slope lengths; plant on uneroded soils. These are fundamental points which operate regardless of terracing or other means of control.

Erosivity of different soil types: The Kirvin fine sandy loam appears to be our most erosive soil; the Nacogdoches fine sandy loam erodes only about one-half as much. Our deeper gray sandy lands (mostly Bowie fine sandy loams and related soils) have a higher absorptiveness for rainfall, and probably erode the least. When waterlogged, as from slow heavy winter rains, these soils wash easily, however. The heavier, more intense summer rains have caused destructive erosion on these soils, also.

Composition of the washoff: Washoff always seems to be higher in content of the finer-textured fertility-carrying soil components, and of organic matter, than the topsoils from which it comes. In other words, erosion removes the "cream of the soil". This has been especially true of terrace and strip-crop washoff, since the sands tend to drop out of suspension first.

Special Experiments, 1933, on pore-clogging effect of fine materials in suspension in the runoff: Experiments in laboratory and on special plats proved that the addition of fine soil materials to runoff waters under sheet erosion conditions

increased the runoff, and enormously increased the erosion. In short,- in cultivated fields, the effect of pelting raindrops is to forcibly throw fine soil material into suspension. These tend to be drawn down into soil pores, and clog them, increasing the runoff if rains continue. Two underlying principles of erosion control were brought out by these experiments: (1) make the soil as absorbent as possible, (by means of dense vegetation and certain soil treatments); (2) keep the runoff water as clear as possible. In this connection, in 1933 an application of 15 tons per acre of oak leaves were added to one of a set of four cotton plats on Kirvin soil sloping 6½%, standard length. The addition of the leaves made the soil so absorbent that almost no runoff nor erosion resulted in the second one-half year, 1933. Without fertilizers, a maximum yield of cotton was obtained - almost a bale to the acre.

Practical Soil Treatments that reduce erosion: Any kind of organic crop residue materials, manure, compost, green manures, - either leguminous or nonleguminous, - when turned under improve soil absorptiveness. Generally, all of these also improve soil productivity. Commercial fertilizers seem to have a very small beneficial effect, except as they tend to thicken up stands and cause better growth of erosion-resistant vegetation.

II. CONTROL BY VEGETATION.

Class 1. The erosion-controlling types of vegetation.

Woodlands: Hardwood forest, burned over each spring, compared to unburned. Average annual losses, 2½ years (July 1931-Dec. 1933), on Kirvin fine sandy loam, 12½% slope, were as follows: Burned over plat, runoff 2.55%, erosion .19 tons per acre. Unburned plat, runoff .75%, erosion .01 tons per acre. This unpastured, unburned native timberland on a rather steep slope has showed almost perfect control of runoff and erosion. The repeated burnings are causing increasing losses, year by year.

Pasture Sod: Three Bermuda sod plats, on slopes varying from 8¾% to 16½%. Both the runoff and erosion losses are exceedingly small on all of these plats, even less than from the unburned woods, and the data shows that the control is improving as the sod becomes better established.

These two types of vegetative cover are almost perfect control measures, in themselves. The method consists simply of getting a good stand, and taking care of it, in either case.

Class 2. Intermediate class or types of vegetation that check erosion to a considerable extent: These are the broadcast or close-drilled forage crops, including perennials, biennials, and annuals. Alfalfa, a perennial, is probably the best of the group. Lespedeza sericea, a sourland substitute for alfalfa, that is showing some promise of success here, is rather erosion-resistant. Sudan grass, red-top sorghum, and close-drilled cowpeas are common crops of the annual group that give good erosion protection for about nine months of the year (with own plus some crabgrass stubble), for winter protection. Kobe and Tennessee #76 lespedezas, both annual summer clovers which self-seed, when spring planted for rotation pasture under field conditions, and followed in the fall by oats, Italian rye grass, and bur clover, have given almost perfect erosion protection after a sod-like vegetation has become established. Some such combination planting as this is very useful for fields no longer in cotton, which may be fenced for pasture, to be plowed out later if desired. Phosphate benefits these lespedezas.

Class 3. Erosion-Provoking Crops: Clean cultivated row crops in general, particularly cotton and corn, permit the most erosion. On this Station they have permitted more erosion than no crop at all (bare fallow land). The common use of these crops is responsible for most of our eroded sloping croplands, gullies and abandoned fields of the South. On Kirvin fine sandy loam soil, sloping 8¾%, continuous cotton, no treatment, standard length plat, three year average losses 1931-1933, were: runoff 18%, erosion 19.06 tons per acre. With corn, in a rotation, they were: runoff 18.0%, erosion 20.00 tons per acre. Cotton in the same rotation, lost in runoff 16.3%, erosion 16.15 tons per acre.

Planting Plans that reduce erosion losses: Strip-cropping without terraces: This is a planting plan much in favor, which consists of planting alternating strips of cultivated crops on contours, and in between, strips of erosion-resistant forage crops. By using the terrace lines as guides, this plan seems well adapted to smooth gentle slopes. A badly gullied field on this Station has been handled in this way since 1931. The gullies were plowed in, and gully seedings of grasses made to protect them. These grass strips are passed over when plowing. The row crop strips are contour backfurrowed on the terrace lines, exactly as in maintaining terraces, so that slight ridges are thrown up. Runoff water is thus directed quickly into the gullies, which are protected against washing. This theory is directly opposite to the theory of terracing. This field is improving as time goes on, and the control of erosion is becoming fairly good, even in a rough gullied slope.

Strip-cropping with terraces: This plan appears to be a distinct improvement over the common plan of simply terracing cultivated fields. The control forage crop strips may be planted on the terrace ridges, channels, and in parts of the lower intervals, so that they (1) stiffen up the ridges; protect them against breaking when over-topped; (2) protect channels from washing; (3) shorten the lengths of row crop slopes. The effectiveness of any strip-cropping plan depends upon the nature of the crops used for control and the way they are handled. The more permanent they are, and the wider the control strip, - the better the protection.

Tyler BWS plan of erosion control (Balk-waterfurrow-strip-crop). This is a new combination planting plan, developed at this Station, which utilizes self-seeding winter legumes with strip-cropping of summer crops. It aims to provide annual leguminous winter cover, contoured balks of dense legume vegetation let stand to reseed in the spring, meanwhile permitting the planting of summer crops in strips between. Contoured waterfurrows replace the balks after legumes make seed, in June. This plan, adapted to terraced fields, should provide excellent erosion protection, and build up the soils, as well. This plan is under extensive tests now, with numerous variations.

Erosion Control Agronomy: Introductions: Many types and varieties of plants that may prove of use in erosion control are constantly being introduced and tried out, at this Station. Five varieties of lespedeza sericea, all of the better annual lespedezas, clovers, alfalfas, and grasses, winter and summer legumes, forage and grain crops are included. Plantings of willows, cottonwoods, loblolly and shortleaf pines, and of grasses, have been made in gullies. Many Bermuda sod-bag dams have been constructed.

To date, sericea 17291 BPI., the thin stem variety, planted 5 lbs. per acre in 18 inch rows, on good soil, hand hoed when small and cultivated twice, has made good growth, and established a perennial stand. Peruvian Alfalfa, when limed and phosphated, apparently succeeds well enough on the best redland soil to justify its use for hay and pasture. Alfalfa does not do well on the Kirvin soil. Kobe and Tennessee #76 are fairly successful self-seeding annuals for pasture on uplands. Too much competition with Bermuda and crab grasses should be avoided. Summer field legumes: Brabham Cowpeas are favored for a summer legume. This crop is drouth resistant, and the seeds are small enough for the close-drilling for strip-crop use.

For summer green manuring only, Crotalaria spectabilis, especially on the deeper sandy lands, has made the largest tonnage. Florida beggarweed has done well on droughty soils, and is useful for fall pasturage. Summer grain: Sagrain (schrock sorghum), an early maturing grain sorghum, is preferred to corn on droughty soils. Like all of the sorghums, it appears that it should be used in a good rotation preferably after a winter legume cover crop has been turned under for green manure, in order to maintain soil organic matter.

Winter pasture clovers and grasses: Supplemental winter annual clovers (all best planted in manure clumps) that have proven the best growers here on Bermuda sod, are Southern spotted-leaf bur clover, subterranean clover, hop clover, and native Carolina clover. ~~Manure and phosphate stimulate the growth~~ of these clovers remarkably. Dallis grass is succeeding in competition with Bermuda grass, and is both a summer and winter grower. Italian rye grass and rescue grass do fairly well the first year, but have not maintained themselves well under pasturage.

Winter field legumes: Woolypod vetch seems best adapted for poor lands, and for self-seeding in the balk plan. It germinates better than Hairy vetch at first vetch seeding; is almost as winter-hardy and productive; has better seeding habits. Austrian Winter Peas have done well on good soil, but have proven unreliable on poor land. Phosphate applications two weeks previous to Fall planting of these winter field legumes is standard practice with us, unless there is plenty of residual phosphate in the soil. Double-rate inoculation is practiced. Many other winter legumes are under test, but none can be recommended excepting the above three. One of the most urgent needs of southern agriculture is a successful winter legume.

III. STUDIES UPON MECHANICAL OR ENGINEERING MEANS AS BY TERRACING, ETC., BOTH ALONE AND IN COMBINATION WITH OTHER METHODS.

The soil losses from unprotected sloping fields with clean cultivated crops are excessive. In 1933, an unterraced area had a soil loss of 41.03 tons per acre. This is the equivalent of about one third of an inch of soil over the entire area. A wooded area of about the same slope had a soil loss of only .03 tons per acre. The eroded cultivated area had 1400 times as much soil loss as the wooded area. This shows how greatly Natures' plan is changed when the sloping land is cleared and planted to clean cultivated crops such as cotton and corn.

The engineering methods of erosion control are an attempt to reduce the erosion losses to a point where production can be maintained or increased and still not seriously change the cropping system used by the better farmers.

Terracing has long been considered an effective means of erosion control and one of our problems is to find the most effective types of terraces for different soils, crops, and land slopes.

Most of the experimental terraces on which clean cultivated crops are grown are on an eroded hillside with a slope of about seven per cent. We have found from results for three years that for long terraces (1700 feet), with uniform grades of 3 inches per 100 feet, the soil losses increase with an increase in vertical spacing. The average yearly soil loss from a long terrace with a five foot spacing was 5.74 tons per acre, for one with a four foot spacing it was 5.47 tons per acre, and for one with a three foot spacing it was 3.68 tons per acre. For short terraces (700 feet) with uniform grades of 3 inches per 100 feet somewhat similar results have been obtained and records for 1933 show a soil loss of 7.68 tons per acre for six foot spacings; 6.62 tons per acre for a four foot spacing;

and 5.32 tons per acre for a three foot spacing. For all terraces in this field the losses for 1933 were greater than the average for the three years.

Results for three years have definitely shown that there are excessive losses for short terraces (700 feet) with a uniform grade of 6 inches per 100 feet, or a variable grade of 0-6 inches per 100 feet. These terraces have a vertical spacing of about 4 feet. For 1933, terraces with these grades had 3.6 times as much soil loss per acre as a level terrace 700 feet long and with a vertical spacing of about 4 feet, on similar soil. A terrace 700 feet long with a vertical spacing of 4 feet and a grade of 3 inches per 100 feet had 1.45 times as much soil loss as the level terrace, but only 40% as much as the terraces with the six inch grades.

For long terraces (1700 feet) a terrace with a variable grade of 0-3 inches per 100 feet, and a vertical spacing of about 5 feet, had an average yearly soil loss of 5.0 tons per acre while a similar terrace with a uniform grade of three inches per 100 feet has had an average soil loss of 5.7 tons per acre per year.

Very long graded terraces do not seem to be desirable. For three years a terrace 1700 feet long has had an average of 1.2 times as much soil loss per acre as a terrace 700 feet long, and 1.9 times as much as a terrace 1100 feet long. All these terraces have a uniform grade of 3 inches per 100 feet and a vertical spacing of 4 feet.

In another field a series of level terraces of different lengths were built. This field is sandy and the soil is quite deep on most of it. Some of these terraces had closed ends and all of the rainfall was held on the field. Because of the heavy rains that sometimes occur here these level closed end terraces were not satisfactory. Since making an outlet at one end of these terraces very satisfactory results have been obtained and the soil losses are small. In 1933, a level terrace with a three foot spacing 2300 feet long had a soil loss of 1.24 tons per acre. There is some standing water behind these terraces after heavy rains, but on the sandy soil it does not remain long enough to seriously damage the growing crop.

The outstanding results to date are:

(1) The soil losses from unprotected slopes with clean cultivated crops are excessive.

(2) Terraces with grades of 6 inches per 100 feet have much more soil loss than level terraces or terraces with grades of 3 inches per 100 feet.

(3) With clean cultivated crops the soil losses increase with the wider spacing of terraces.

(4) Very long graded terraces are not as effective as short or intermediate length terraces.

(5) Closed end level terraces are not satisfactory even on the deeper sandy land.

(6) On the deeper sandy soils and gentler slopes level terraces open at one end are very effective if carefully built and maintained.

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